

Docket No.: 09785980-0054

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of Hiok-Nam. Tay

Examiner: Unassigned

Application No.: 09/982,540

Group Art Unit: 2878

Filed: October 17, 2001

For: ARRANGEMENT OF  
MICROLENSSES IN A SOLID-STATE  
IMAGE SENSOR FOR IMPROVING  
SIGNAL TO NOISE RATIO

**AFFIDAVIT**

I, Daniel N. Yannuzzi, Vice President, Chief IP Counsel of Conexant Systems, Inc., 4311 Jamboree Road, Newport Beach, California 92660-3095, United States of America, do solemnly and sincerely declare and say as follows:

Efforts to locate the inventor Tay Hiok-Nam have been unsuccessful. We respectfully submit a copy of the inventor's employment agreement.

DECLARED at Newport Beach, California

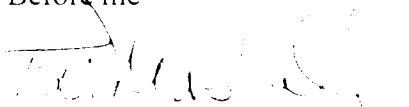
on February 15 2002

By: \_\_\_\_\_

Name: Daniel N. Yannuzzi

Title: Vice President, Chief IP Counsel

Before me

  
\_\_\_\_\_  
Notary Public

# Employment Agreement

## CALIFORNIA EMPLOYEES



ONEXANT™

Last Name	Suffix	First Name	Middle Initial	Employee ID or SS#	Hire Date
Tay		Hiok-Nam		00407650	11/22/1999

til you have fulfilled all conditions of employment and the Employment Certification, Invention, Secrecy Agreement, Non-Solicitation of Co-Workers and other clauses appearing below have been signed by you and by our authorized agent, you are not employed by this Company.

### Employment Certification

I realize that the terms of my employment shall be in accordance with Company policies, rules, and regulations that may be posted or published at any time. I understand that changes in the type of work, hours, rates of pay, shift, days off and total hours worked each day or week may be made at the discretion of the Company.

### Invention Agreement

In partial consideration of my employment by Conexant Systems, Inc., one of its subsidiaries, their successors or assigns (hereinafter "Conexant"), I agree that I will promptly disclose to Conexant any invention, discovery, idea or improvement, whether or not patentable (hereafter termed "invention" or "inventions") that I make, suggest, conceive, devise or first actually reduce to practice, solely or jointly with others, during said employment, and which at the time of disclosure to Conexant or at the time of making, suggesting, conceiving, devising or first actually reducing to practice that (a) results from or is related to any assignments given to or assumed by me, or (b) is subject to any contractual obligation of Conexant to a third party, or (c) utilized the time, equipment, supplies, facilities, or trade secret information of Conexant, or (d) pertains to any actual or anticipated Conexant work, product, research, business activity, or any logical extension thereof, and I will assign and do hereby assign to Conexant my entire right, title and interest (domestic and foreign and including all rights under the International Convention for the Protection of Industrial Property) in all such inventions, subject to the requirements of law, and without further compensation or award of any kind to me from Conexant, or any customer. I further agree, in connection with any such invention, I will at any time, either during or after said employment, at the request and expense of Conexant, but without further consideration to me from Conexant, assist Conexant in obtaining, maintaining and enforcing patents on such inventions in any and all countries and will execute, acknowledge and deliver any lawful document or paper which in the opinion of Conexant's counsel is necessary or helpful from Conexant's standpoint, including without limitation, any patent application, assignment, license, or any paper in connection with any contractual obligation, litigation or controversy pertaining to any such invention or any patent issuing thereon.

I am aware of the provisions of the Labor Code of California, Sections 2870-2872, which are set forth below and which shall apply while I am employed by Conexant, one of its subsidiaries, their successors or assigns, in the State of California. I agree that all inventions made by me solely or jointly with others during the term of my employment will be identified to Conexant promptly upon my conceiving such inventions. Upon request by Conexant, I will disclose (by a full and clear description sufficient to enable a person skilled in the art to make and use such inventions) to Conexant such inventions in confidence, for review by Conexant of such issues as may arise.

Labor Code, State of California (Div. 3, Chapter 2, Article 3.5 enacted September 26, 1979)

2870. (a) Any provision in an employment agreement which provides that an employee shall assign, or offer to assign, any of his or her rights in an invention to his or her employer shall not apply to an invention that the employee developed entirely on his or her own time without using the employer's equipment, supplies, facilities, or trade secret information except those inventions that either: (1) Relate at the time of conception or reduction to practice of the invention to the employer's business, or actual or demonstrably anticipated research or development of the employer. (2) Result from any work performed by the employee for the employer. (b) To the extent a provision in an employment agreement purports to require an employee to assign an invention otherwise excluded from being required to be assigned under subdivision (a), the provision is against the public policy of this state and is unenforceable. (As Amended Stats. 1986, c. 346, §1)
2871. No employer shall require a provision made void and unenforceable by Section 2870 as a condition of employment or continued employment. Nothing in this article shall be construed to forbid or restrict the right of an employer to provide in contracts of employment for disclosure, provided that any such disclosures be received in confidence, of all of the employee's inventions made solely or jointly with others during the term of his or her employment, a review process by the employer to determine such issues as may arise, and for full title to certain patents and inventions to be in the United States, as required by contracts between the employer and the United States or any of its agencies.
2872. If an employment agreement entered into after January 1, 1980, contains a provision requiring the employee to assign or offer to assign any of his or her rights in any invention to his or her employer, the employer must also, at the time the agreement is made, provide a written notification to the employee that the agreement does not apply to an invention which qualifies fully under the provisions of Section 2870. In any suit or action arising thereunder, the burden of proof shall be on the employee claiming the benefits of its provisions.

### 3. Company Property

All documents or things coming into my possession, custody or control by virtue of my employment (except those documents directed to me as an employee for my personal use and identified by Conexant as being the property of the employee) are the property of Conexant (or Conexant's customers, as the case may be) and all of such property in my possession, custody or control at the time of termination of my employment will be delivered to Conexant at that time.

### Secrecy Agreement

If during the period of my employment I have access to any information, technical or otherwise, including any computer software, which is confidential or proprietary to Conexant, its customers, subcontractors and any other individuals or companies having any kind of association or relationship with Conexant, I will not, except as required by my duties as an employee of Conexant, use or disclose or authorize anyone else to use or disclose, any such information, either during my employment or thereafter for so long as such information is not publicly or generally known. Anything possessed by me which discloses or embodies such information will be delivered to Conexant prior to my leaving its employ. I agree not to disclose information concerning the work-in-progress at Conexant to anyone not authorized to receive it.

### Agreement Regarding Employment

I acknowledge that my employment is of indefinite duration and that it can be terminated with or without cause and notice at any time, either by Conexant or me, except as otherwise provided by the terms of a collective bargaining agreement applicable to me. I understand that no member of management, or other official or agent of Conexant has the authority to make any agreement (oral, written, or implied) or other representations contrary to the above statement. However, an officer of the Company can do so in written agreement signed by the officer and me.

### Non-Solicitation of Co-Workers

I acknowledge that Conexant makes a considerable investment in the recruitment and training of its employees and that the loss of its employees to other companies can damage Conexant financially. I understand that as an employee I will become familiar with the expertise, skills and abilities of my co-workers and that Conexant considers this information to be proprietary information that must not be disclosed to its competitors. In consideration of my employment with Conexant, it is agreed that both while employed by Conexant and for a period of eighteen (18) months after my employment ends, I will not solicit nor will I assist any other company in soliciting any Conexant employee to leave Conexant and join another company. I also agree that in addition to any damages that may be recovered, the prevailing party in any legal action to enforce this non-solicitation agreement shall be entitled to recover its costs and attorneys' fees from the other party.

Conexant Systems, Inc.		
		11/22/1999
Signature - Employee	Signature - Authorized Agent	Date

Employee ID#: 00407650

Hiok-Nam Tay

Voluntary Agreement

EMPLOYEE ACKNOWLEDGES THAT HE OR SHE HAS CAREFULLY READ THIS AGREEMENT AND THE ATTACHED ARBITRATION PROCEDURE, THAT HE OR SHE UNDERSTANDS ITS TERMS, THAT ALL UNDERSTANDINGS BETWEEN THE EMPLOYEE AND THE COMPANY RELATING TO THE SUBJECTS COVERED IN THIS AGREEMENT ARE CONTAINED IN IT, AND THAT HE OR SHE HAS ENTERED INTO THIS AGREEMENT VOLUNTARILY AND NOT IN RELIANCE ON ANY PROMISES OR REPRESENTATIONS BY THE COMPANY OTHER THAN THOSE CONTAINED IN THIS AGREEMENT ITSELF.

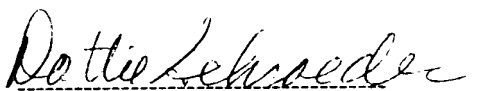
EMPLOYEE FURTHER ACKNOWLEDGES THAT HE OR SHE HAD AN OPPORTUNITY TO DISCUSS THIS AGREEMENT WITH HIS OR HER PERSONAL LEGAL COUNSEL AND HAS USED THAT OPPORTUNITY TO THE EXTENT HE OR SHE WISHES TO DO SO.

EMPLOYEE

CONEXANT SYSTEMS, INC.



Signature of Employee

  
for D. T. Lynch 11/22/1999  
Executive Director, Employee Relations  
Human Resources

Hiok NAM Tay  
Print Name of Employee 11/22/1999

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

INVENTORS: Hiok-Nam TAY  
ATTORNEY DOCKET NO.: 09785980-0054  
SERIAL NO.: 09/982,540 GROUP ART UNIT: To be assigned  
FILED: October 17, 2001 EXAMINER: To be assigned  
TITLE: "ARRANGEMENT OF MICROLENSES IN A SOLID-STATE IMAGE SENSOR  
FOR IMPROVING SIGNAL TO NOISE RATIO"

**STATEMENT OF KNOWLEDGE PER MPEP 409.03(f)  
TO SUPPORT PROOF OF PROPRIETARY INTEREST**

I, Prasan K. Pai, upon information and belief do solemnly and sincerely state as follows:

That at the time Hiok-Nam Tay was employed by Conexant Systems, Inc., my relationship to Hiok-Nam Tay was that of supervisor in that Hiok-Nam Tay reported directly to me.

That I have reviewed and understand the contents of the Conexant Systems, Inc. Employment Agreement signed by Hiok-Nam Tay on November 22, 1999. I understand that by signing this Employment Agreement, Hiok-Nam Tay agreed to, among other things, assign to Conexant Systems, Inc. all inventions made during his employment with Conexant Systems, Inc. subject to the requirements of law.

That I have reviewed and understand the contents of the above-identified patent application, including the claims.

That I have firsthand knowledge of the facts that the invention of the above-identified patent application was made by Hiok-Nam Tay during the employment of Hiok-Nam Tay by Conexant Systems, Inc.

That the attached five page invention disclosure statement was prepared by Hiok-Nam Tay during the employment of Hiok-Nam Tay by Conexant Systems, Inc. and was submitted by Mr. Tay to Conexant Systems, Inc. during the employment of Hiok-Nam Tay by Conexant Systems, Inc.

That all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Name/Title: Prasan K. Pai, Director, Technology Planning

Signature: Prasan K. Pai

Date: May 1, 2002

Post Office Address:

Conexant Systems, Inc.  
4311 Jamboree Road, M/S E08-802  
Newport Beach, California 92660-3095  
United States of America

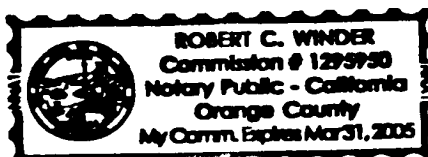
**INDIVIDUAL ACKNOWLEDGEMENT  
COUNTY OF ORANGE, STATE OF CALIFORNIA**

On the 1 day of May, 2002 before me personally appeared Prasan K. Pai known to me or proved to me on the basis of satisfactory evidence to be the individual described in and who acknowledged the foregoing instrument and swore and acknowledged that he executed the same as his free act and deed.

Notary Public: Robert C. Winder

My Commission Expires March 31, 2005

FRC/VPT/rmg/#14218756.1



3/20/2000



Docket No.:  
Ranking: NO RANK

1. Title of Innovation

Microlens Arrangement

2. Division/platform Information

Personal Imaging Division

3. Innovator(s)

Name	Innovator Information
Hlok-Nam Tay	<div>Personal Information :</div> <div>Home Address : 230 Saint Vincent</div> <div>State : CA</div> <div>Phone : 9493875148</div> <div>Country of Domicile : US</div> <div>City : Irvine</div> <div>Zip : 92618</div> <div>Fax :</div> <div>Citizenship : US</div> <div>Conexant Contact Information :</div> <div>Address : 4311 Jamboree RoadP. O. Box C,</div> <div>State : CA</div> <div>Phone : 949-483-5947</div> <div>Email : hloknam.tay@conexant.com</div> <div>Mail Code : 350-</div> <div>City : Newport Beach</div> <div>Zip : 92660-3095</div> <div>Fax :</div> <div>Dept : 872-</div> <div>Supervisor : Mr. Eric Huang</div>

4. Problem Solved

Silicon Image Sensors uses Microlens to focus light onto photodiode or photogate area to improve the effective fill factor. However, conventional Microlens is made of resist, which require neighboring Microlenses to satisfy a minimal gap of typically  $0.8\mu\text{m}$ . For a small pixel, say  $3.5\mu\text{m}$ , this leaves  $2.7\mu\text{m}$  for the Microlens diameter and thus Microlens only covers  $(\pi/4)(2.7/3.5)^2=47\%$  of the pixel area. If the pixel has as drawn fill factor of 40%, the additional 7% is not going to help much vis-a-vis the cost incurred. Figure 1 shows this Prior Art.

Without an effective fill factor improvement, the blue pixel response is typically 2 to 3 times weaker than the red pixel. Hence in the color postprocessing step an effective gain of 2 to 3 times has to be applied to the blue pixel relative to the red pixel, and in this process amplifies noise and degrades signal-to-noise ratio.

A weaker response on the blue pixel also affects color fidelity in the presence of crosstalk. Green and Red light crosstalk to blue pixel is typically on the order of 10%. Assuming sensitivity ratio of 1(Blue):2(Green):3(Red), then the crosstalk from 4 nearest Green pixels is  $4*2*0.10=0.8$  and from 4 nearest Red pixels is  $4*3*0.1=1.2$ , adding up to a total of 2.0, whereas signal is only 1.0, resulting in signal-to-crosstalk ratio of only 1/2 or -6dB. Crosstalk correction normally is effectly taking the neighboring pixels' signal level, multiply by a set of pre-calibrated crosstalk coefficients, and subtracted from the blue pixel readout level to obtain an approximation to the blue signal level. But due to part-to-part variation of these crosstalk coefficients, there is a certain amount of color error. It is thus important to reduce the color error by improving the original signal by way of improving the effective fill factor of the blue pixel.

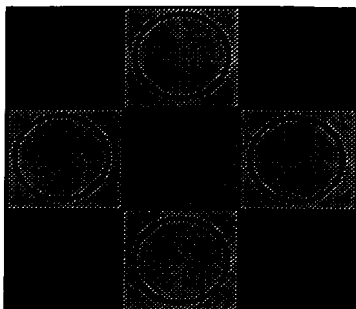
## **5. Previous Solutions**

There is no known solution.

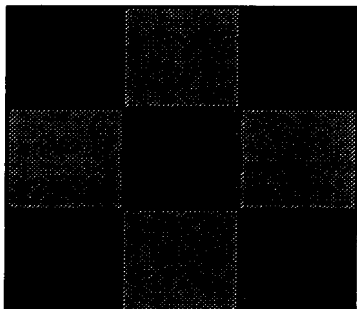
## **6. Solution**

This inventor's idea is to make Microlens on top of the blue pixel only, and not have any Microlens on the Green or Red pixel. Figure 2 shows this invention.

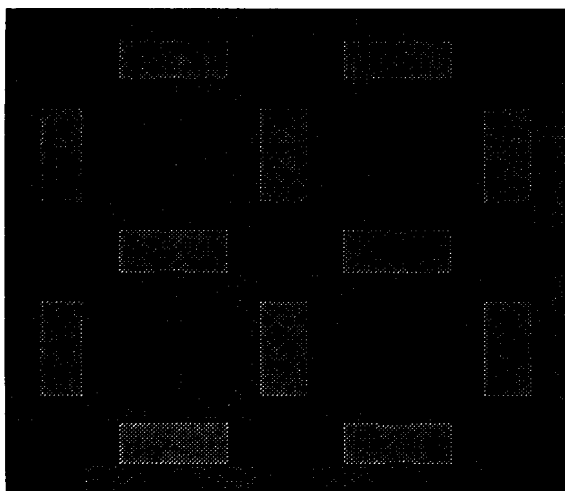
A further extension of this idea is to make the Blue Microlens diameter bigger than the blue pixel itself to obtain effective fill factor of 100% or greater. Figure 3 shows an extension of this invention.



**Figure 1 (Prior Art) Microlenses on all pixels**



**Figure 2 Microlens on blue pixel only. Microlens diameter is as large as pixel size.**



**Figure 3. Blue Microlens and Blue Filter are larger than pixel size.**

## 7. Differences/Advantages Over Previous Solutions

Advantage of having only "Blue Microlens" (i.e. Microlens on top of blue pixel) and none of "Green Microlens" or "Red Microlens" is that the Microlens diameter can be as large as the pixel size. Using the aforementioned example, the Blue Microlens diameter would then be 3.5 $\mu$ m, and hence the Blue Microlens covers  $(\pi/4)=78\%$  of the pixel area.

There is good reason to apply Microlens to only Blue pixel and neglect the Green and Red pixels, basically due to the vastly differing absorption depth among them (Red: 0.5 $\mu$ m, Green: a few  $\mu$ m, Red > 5 $\mu$ m). Blue pixel essentially only generates carriers near the silicon surface, and so light need to be focus onto the generation area, like photodiode or photogate. Using a Microlens to bring light from all over the pixel surface to the photodiode or photogate will directly improve the number of carrier-hole pair generated. Green and Red light penetrate further deeper and sideways into the silicon, so light impinging on non-obstructed (i.e. by metal or contact or poly) silicon surface would go deep into the silicon and generate electron-hole pairs, which diffuses to the photodiode or photogate. Thus having Microlens for the Green or Red pixels would not have as much impact as compared with Blue pixel.

A further extension is to make the Blue Microlens diameter bigger than the pixel size itself. This has dual advantages:

1. The blue light collected and directed to the blue pixel's photodiode or photogate increases further, and
2. The distance from the blue pixel's photodiode or photogate to the nearest silicon area where green or red light is absorbed is increased, thus reducing crosstalk from these two colors.

## 8. Status of Innovation

Idea                      If "Other", please specify

## 9. Product or program in which innovation will be used:

<b>Products Used :</b> Digital Imaging	<b>Technology Used :</b> CMOS Imager
<b>If other, please specify :</b>	<b>If other, please specify :</b>

<b>Additional Information :</b>	
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## 10. Has anyone disclosed or does anyone plan to disclose your innovation outside the Company?

☐ Yes      ☒ No      ☐ Don't Know



11. Has anyone proposed or does anyone plan to propose a product or program to a customer which includes your innovation?

☐ Yes      ☒ No      ☐ Don't Know

12. Innovator signature(s): (Do not use black ink)

\_\_\_\_\_  
(HIOK-NAM TAY)      Date : \_\_\_\_\_

Qtr Evaluated:                      2Q00  
Group:                                Personal Imaging Division  
Technology:  
Sub Technology 1:  
Sub Technology 2:  
Products:  
Innovation Block:

Entered:    Hiok-Nam Tay @ 03/16/2000 03:23:42 PM  
Modified:    Hiok-Nam Tay @ 03/20/2000 02:41 PM